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Institution: Beijing-Dublin International College
Module: University Physics 2 (BDIC2008J)
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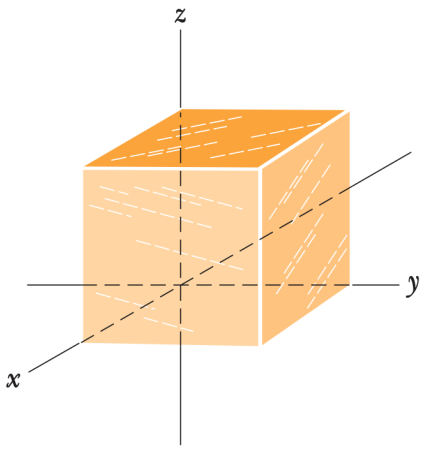
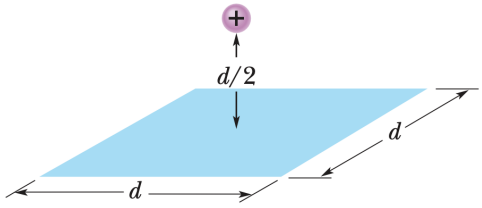
Problem Set 2

Gauss' Law

Problem 1. *The cube in the figure has edge length* 1.40m *and is oriented as shown in a region of uniform electric field. Find the electric flux through the right face if the electric field, in newtons per coulomb, is given by* ***(a)*** $6.00\vec{i}$, ***(b)*** $-2.00\vec{j}$, *and* ***(c)*** $-3.00\vec{i} + 4.00\vec{k}$. ***(d)*** *What is the total flux through the cube for each field?*



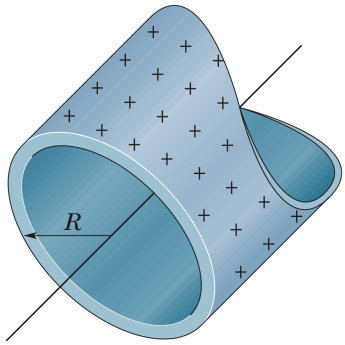
Problem 2. *In the figure below, a proton is a distance $d/2$ directly above the centre of a square of side d. What is the magnitude of the electric flux through the square? (Hint: Think of the square as one face of a cube with edge d.)*



Problem 3. *The electric field in a certain region of Earth's atmosphere is directed vertically down. At an altitude of* 300m *the field has magnitude* 60.0N/C*; at an altitude of* 200m*, the magnitude is* 100N/C*. Find the net amount of charge contained in a cube* 100m *on edge, with horizontal faces at altitudes of* 200 *and* 300m*.*

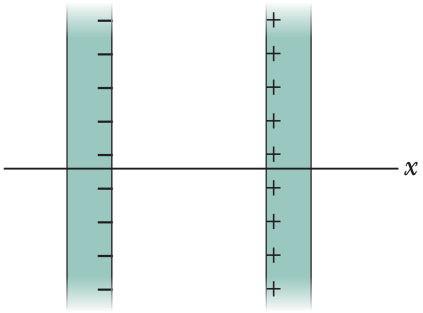
Problem 4. *Space vehicles travelling through Earth's radiation belts can intercept a significant number of electrons. The resulting charge buildup can damage electronic components and disrupt operations. Suppose a spherical metal satellite* 1.3m *in diameter accumulates* 2.4μC *of charge in one orbital revolution.* ***(a)*** *Find the resulting surface charge density.* ***(b)*** *Calculate the magnitude of the electric field just outside the surface of the satellite, due to the surface charge.*

Problem 5. *This figure shows a section of a long, thin-walled metal tube of radius* $R = 3.00\text{cm}$*, with a charge per unit length of* $\lambda = 2.00 \times 10^{-8}\text{C/m}$*. What is the magnitude* E *of the electric field at radial distance* ***(a)*** $r = R/2.00$ *and* ***(b)*** $r = 2.00R$*?* ***(c)*** *Graph* E *versus* r *for the range* $r = 0$ *to* $2.00R$*.*

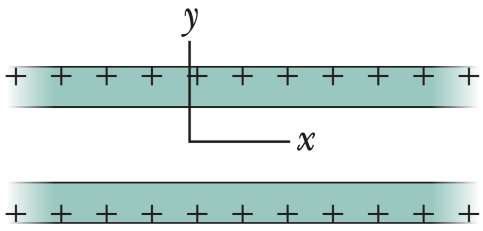


Problem 6. *A long, straight wire has fixed negative charge with a linear charge density of magnitude* 3.6nC/m. *The wire is to be enclosed by a coaxial, thin-walled nonconducting cylindrical shell of radius* 1.5cm. *The shell is to have positive charge on its outside surface with a surface charge density* σ *that makes the net external electric field zero. Calculate* σ.

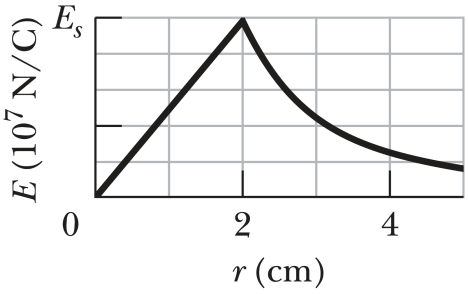
Problem 7. *In the figure below, two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have excess surface charge densities of opposite signs and magnitude* $7.00 \times 10^{-22}\mathrm{C/m}^2$. *In unit-vector notation, what is the electric field at points* ***(a)*** *to the left of the plates,* ***(b)*** *to the right of them, and* ***(c)*** *between them?*



Problem 8. *The Figure below shows cross sections through two large, parallel, non-conducting sheets with identical distributions of positive charge with surface charge density* $s = 1.77 \times 10^{-22}\mathrm{C/m}^2$. *In unit-vector notation, what is* $\vec{E}$ *at points* ***(a)*** *above the sheets,* ***(b)*** *between them, and* ***(c)*** *below them?*



Problem 9. *The figure below gives the magnitude of the electric field inside and outside a sphere with a positive charge distributed uniformly throughout its volume. The scale of the vertical axis is set by* $E_s = 5.0 \times 10^7 \mathrm{N/C}$. *What is the charge on the sphere?*



Problem 10. *The solid sphere of radius* $a = 2.00\text{cm}$ *is concentric with a spherical conducting shell of inner radius* $b = 2.00a$ *and outer radius* $c = 2.40a$*. The sphere has a net uniform charge* $q_1 = +5.00\text{fC}$*; the shell has a net charge* $q_2 = -q_1$*. What is the magnitude of the electric field at radial distances* ***(a)*** $r = 0$*,* ***(b)*** $r = a/2.00$*,* ***(c)*** $r = a$*,* ***(d)*** $r = 1.50a$*,* ***(e)*** $r = 2.30a$*, and* ***(f)*** $r = 3.50a$*? What is the net charge on the* ***(g)*** *inner and* ***(h)*** *outer surface of the shell?*